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A Rediscovery of Scientific Collections as Material Heritage?

The Case of University Collections in Germany.

David Ludwig and Cornelia Weber

The purpose of this article is twofold: on the one hand, we present the outlines of a history of university collections in Germany. On the other hand, we discuss this history as a case study of the changing attitudes of the sciences towards their material heritage. Based on data from 1094 German university collections, we distinguish three periods that are by no means homogeneous but offer a helpful starting point for a discussion of the entangled institutional and epistemic factors in the history of university collections. In the 19th century, university collections were institutionalized and widely recognized as indispensable in research and teaching. During the 20th century, university collection became increasingly marginalized both on an institutional and theoretical level. Towards the end of the 20th century, the situation of university collections improved partly because of their reconsideration as material heritage.

University collections preserve a large variety of scientific objects such as astronomical instruments, mathematical models, geological samples, taxidermies, herbaria, and archaeological excavation pieces. Despite their often crucial importance for the development of scientific disciplines, university collections have long been neglected in the history of science. Recent debates about the material dimension of scientific practice have challenged this situation and contributed to a quickly growing number of publications on university collections and their holdings. However, most of these studies focus on individual objects,

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individual collections, or collections of individual universities (e.g. Hoffmann and Maak-Rheinländer, 2001; Kunst, Schnalke, Bogusch, 2010). Macrohistorical accounts that examine the general history and significance of university collections are still sparse (an important exception is Lourenço, 2005) and entirely missing in the case of university collections in Germany.

The aim of this article is twofold. On the one hand, we present an account of the development of university collections in Germany. On the other hand, we want to discuss the recent history of university collections as a case study of the changing attitudes of the sciences towards their material heritage. The first two sections introduce the data and methodological assumptions of our study. We base our discussion on data from 1094 collections at German universities. We argue that this data provides crucial insights into the development of university collections in general as well as in specific disciplines. Furthermore, we try to go beyond this data by examining the diverse epistemic and non-epistemic functions of university collection in the light of concrete case studies.

In the remaining three sections, we outline a history of university collections in Germany. Although the developments of different disciplines are by no means homogeneous, we still think that it is possible and helpful to distinguish three major periods of the history of university collections in Germany. The first period spans from the late 18th to the early 20th century and is characterized through the emergence of modern university collections across the disciplines. We argue that collection-based research as well as collection-based teaching was widely recognized as indispensable at German universities during this time. The situation changed, however, during the 20th century and we show that university collections

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became increasingly marginalized especially during the second half of the 20th century. This does not mean that university collections lost all functions in research and teaching but they were often pushed to the periphery of disciplines by the dominance of laboratory work and other research projects that did not utilize scientific collections. In the last section we discuss developments since the end of the 20th century and argue that they indicate a reconsideration of university collections as material heritage.

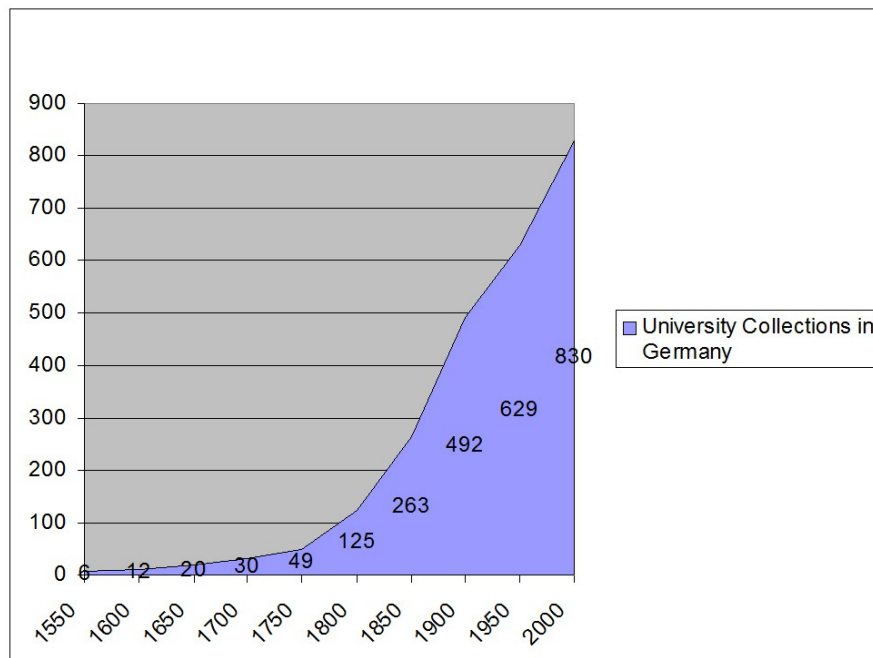
By presenting a macrohistorical account of the development of German university collections, we also hope to provide a case study of the changing attitudes of the sciences towards their material heritage. In particular, we argue that the institutional marginalization of university collections during the second half of the 20th century also reflects a theoretical marginalization of scientific collections. Scientists often stopped paying attention to epistemic potentials of collections and moved on to areas they considered more fruitful and timely. Furthermore, the reconsideration of university collections towards the end of the 20th century was at least partly caused by a general reconsideration of science as having not only a theoretical but also a material heritage.

I The Available Data

Although historians of science increasingly recognize the importance of university collections, macrohistorical accounts of the development of university collections are hard to find. The main reason for this gap in research is the poor documentation, especially of smaller scientific collections at universities. Often, universities do not even know about their

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own collections and the insufficient data makes it tremendously difficult for historians to present reliable results about development of university collections. Our account is based on the data from a research project that gathers information about university collections in Germany since 2004. Although the results of this research project are publicly available in an online database¹, this article provides the first attempt to utilize the data for a general account of the development of university collections in Germany. As of April 2012, 1094 collections are documented in the database. 769 of them have a precise year of foundation and for another 184, we were able to provide at least a rough estimate for the founding dates. Furthermore, we know of 101 university collections that were destroyed or disbanded before 2000. Table I shows the growth of the number of university collections between 1550 and 2000 as suggested by this data:



¹ See www.universitaetssammlungen.de

Table I: Growth of the number of university collections between 1550 and 2000 according to the database.

It is important to keep the limitations of our data in mind. Although the data has been carefully collected in a collaborative multi-year project, it should not be considered complete. The most important limitation of the data for an analysis of the historical development of university collections is that it is probably biased in favour of more recent collections. Many older collections are not included in the data set because there is no documentation of them or because the only traces of them are hidden in university archives. A second limitation is that the “founding date” of a university collection is often very difficult to determine. This is not only due to a lack of historical information but also a definitional issue. Often, scientists slowly accumulate objects that finally become a university collection. In some instances, an accumulation of scientific objects becomes recognized as a scientific collection at a specific time. In other cases, there is no formal institutionalization of a collection and it is up to a historian to determine an appropriate “founding date.”

A third aspect that needs to be considered is the definition of “university collection.” Following the database, we define “university collections” as collections of three dimensional or audio-visual objects at institutions of higher education. It is important to understand what collections are excluded and included by this definition. On the one hand, the definition excludes libraries and university archives as well as scientific collections that were never affiliated with universities such as many museums and collections of scientific academies or companies. On the other hand, the definition includes collections that are

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affiliated with universities even if they are not scientific collections in a strict sense. Examples include art collections at universities or memorial places such as Friedrich Schiller’s “garden house” at the University of Jena. Furthermore, the definition also includes botanical gardens and aquaria as collections. Other definitions would be possible and would lead to different data.

Despite these limitations, the available data provides a helpful starting point for a discussion of the history of university collections in Germany. This becomes already apparent in the case of *Table I* that indicates some very general trends: until the second half of the 18th century, the number of university collections grows very slowly. After 1750, this growth quickly accelerates and reaches its peak between 1850 and 1900. In the 20th century, this growth slightly decelerates despite the reasonable assumption that the data is skewed in favour of more recent collections.

Table I does, however, suggest rather more stability than there may, in fact, have been over the past 250 years. One way of reaching a more adequate picture is to look at the foundations of scientific collections in different disciplines. Our data allows discipline specific analysis, as every database entry of a university collection is connected to metadata that specifies appropriate disciplines. Table II shows the number of newly founded university collections in astronomy, ethnology, mathematics, and forestry in the 17th, 18th, 19th, and 20th century. The table illustrates that the developments within different disciplines were extraordinarily uneven.

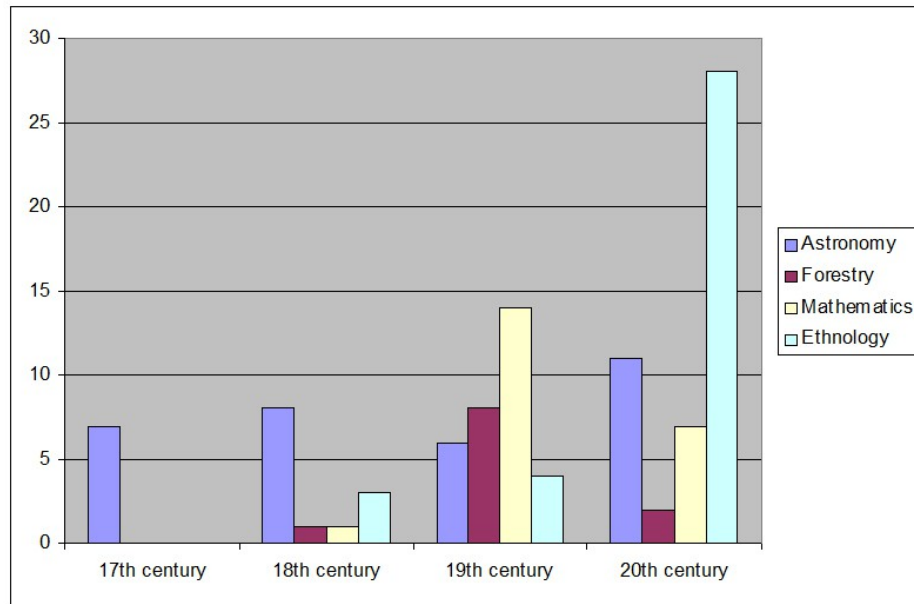


Table 2: Data on the number of newly founded collections (y) in the 17th, 18th, 19th, 20th century (x) .

II The functions of university collections

Even if it is possible to estimate the changing numbers of university collections in different disciplines, the data of the last section provides a very incomplete picture as it says nothing about the functions of these collections in scientific practice. In this section, we will outline a model of the epistemic functions of university collections that we will apply to different case studies in the following sections. On a very broad level, one can distinguish between three functions: University collections can be *research collections*, *teaching collections*, and collections that serve the *public presentation of science*. Of course, these functions are not mutually exclusive, and it is very common for collections to serve more than one of these

purposes. Botanical gardens, for example, are usually open to the public as well as used in botanical research and academic education.

An adequate historical analysis, however, needs a more fine grained account. Research collections, for example, can be used in highly diverse research contexts. *First*, they can provide experimental equipment. Obvious examples are collections of instruments such as the collection of astronomical and geodetic instruments at the Dresden University of Technology or the physical collection of the Darmstadt University of Technology.² *Second*, research collections can also provide the objects of research. Well-known examples are collections that are based on expedition materials such as plants, animals, or geological samples. *Third*, research collections can serve as archives that provide reference objects for scientists. Typical examples include herbaria that constitute a very common type of university collections. *Fourth*, objects in research collections can also be considered research publications as Nick Hopwood has shown in the case of the wax embryos of the Ziegler studio (Hopwood, 2004). Further examples of research functions could be given and this functional diversity makes broad labels such as “research collection” or a “teaching collection” insufficient. Instead, a fine-grained description of the functions of university collections in research, teaching, and the public presentation of science is necessary.

Functions of scientific collections are by no means static but change considerably over time. Often, scientific collections lose some or all of their original functions. Obvious examples are collections of instruments that used to be experimental research collections but lost their original functions as the instruments became outdated or unsuitable for new research

² Information about individual collections and their histories that is not referenced through specific literature stems from the database entries at www.universitaetssammlungen.de where further literature is also available.

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projects. However, university collections not only lose but also gain new functions. Even if most instrument collections at universities have lost their original research functions, they have also gained new functions in the sense that they are now considered important for research in the history of science or for the public presentation of the history of a discipline. Collections can also gain non-historical research functions. Consider, for example, herbaria that constitute an important type of botanical collections. Herbaria have gained new research functions through new methods such as DNA analysis as well as new questions in ecological, evolutionary, and microbiological research (see section IV).

This dynamic model of a functional change also sheds light on the changing *values* of scientific objects and collections. Initially, a scientific object has often a value that is derived from a specific function in scientific practice. An instrument may have a value as an experimental tool, a biological model may have a value as a teaching aid, and a geological sample from an expedition may have a value as an object for further research. As the functions of scientific objects change, their values change, as well. Sometimes, scientific objects lose their initial value without gaining new values. In these cases, scientific objects become treated as “rubbish” and are often thrown away. Entire collections can have this fate when they lose their original functions and become considered valueless. However, often collections lose and gain functions simultaneously and accordingly their values develop in more complicated ways (see Meadow, 2010). These transformations are of utmost importance for an account of the development of university collections and require an analysis of case studies that goes beyond the data we introduced in the last section.

III The Emergence of Modern University Collections

The first documented collection at a German university is the art collection of the University of Greifswald that dates back until 1456. Among the first *scientific* collections at German universities are the botanical gardens of Leipzig (1580), Jena (1586), Heidelberg (1593), and Gießen (1609). Apart from botanical gardens, there is little documentation of scientific collections at German universities of the 16th and 17th century. Although we know about a few astronomical or anatomical collections in Rostock, Gießen, Nürnberg, and Marburg, our database has only 29 entries for university collections before the 18th century. If we exclude art collections and other non-scientific institutions, the number further reduces to 21.

The situation begins to change in the second half of the 18th century. At the University of Göttingen alone, ten collections are founded between 1750 and 1789. The case of Göttingen also illustrates the growing diversity of collection types. Examples include an ethnographical collection with objects from Oceania and the Arctic regions, a collection of historical coins, and Johann Friedrich Blumenbach's skull collection. A similar development takes place in Freiberg, where the *Bergakademie* (mining academy) was founded in 1765. In the first two decades of its existence, the *Bergakademie* created at least seven collections, including mineralogical collections, instrument collections, and a collection of teaching models.

According to our database, the number of university collections more than doubled between 1750 and 1800 and it seems fair to characterize the collections of Göttingen and Freiberg as the first examples of modern university collections in Germany. While Göttingen and Freiberg remain exceptions during the 18th century, the situation changes dramatically in the

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19th century. According to our database, the number of university collections grew from 108 to 492 during the 19th century. There may be a bias in our data set as the 19th century is better documented than earlier centuries, but there can be no doubt about the stunning growth of the number of university collections during that time.

An explanation of this growth will have to take the general changes of universities in Germany into account. One of the most obvious and important features of this process is the increasing number of students. In 1900 there were 32,824 students at the German universities, compared to only 16,000 students in 1830 (Lexis 1904, p. 652). Given this data, it is tempting to explain the increasing number of university collections in terms of a general growth of universities. The growing number of students (and scientists) led to a growing demand for teaching (and research) aids. While there is certainly some truth to this explanation, it can be only part of the story. Another important aspect is the emergence of new disciplines and trends within existing disciplines that required new scientific objects.

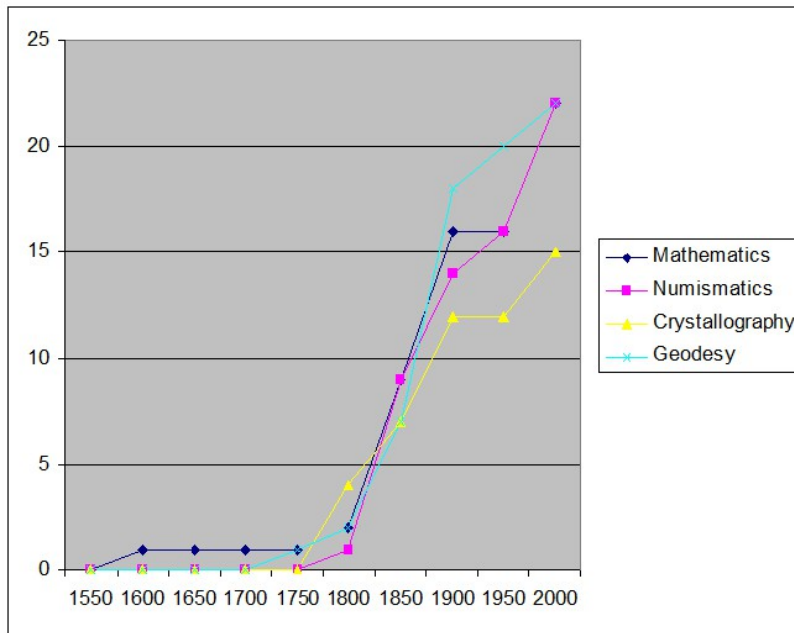


Table III: Discipline-specific growth of the number of university collections between 1550 and 2000 according to the database.

The developments presented in *Table III* illustrate that the increasing number of university collections is not only a result of the general growth of universities. Instead, the development has to be understood in the context of the establishment of new scientific disciplines and new priorities within existing disciplines. The rise of numismatic collections, for example, is the direct consequence of the widespread establishment of history as an academic discipline at German universities. With the institutionalization of history at German universities, numismatics became increasingly considered as *Hilfswissenschaft* (“auxiliary science”) of academic importance and the establishment of numismatic collections reflects this development. Crystallography and geodesy were not new disciplines in the 19th century but they gained new importance through the economic needs of the industrialization of Germany. As a consequence, many of the crystallographic and geodetic collections were

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established at the *Technische Hochschulen*, i.e. institutions of higher education that focussed on engineering sciences. The rise of mathematical collections in Germany requires a different explanation and is connected to new didactic concepts. Most mathematical collections of the 19th century were model collections that were used in teaching geometry. Although mathematical models are already documented for the 18th century, they became popular teaching tools in the second half of the 19th century, and this was the main reason for the creation of new mathematical collections.

So far, we have argued that the dramatic increase of the number of university collections in the 19th century has to be understood in the context of the general growth of universities as well as the establishment of new types of university collections. In the remainder of this section, we want examine the functions of university collections in the 19th century and argue that their widespread institutionalization came with their recognition as indispensable both in research and education.

Large institutions such as the Museum of Natural History in Berlin offer the most convenient examples of the diversity of uses of university collections. The Museum of Natural History has its roots in the Zoological Museum that was founded in 1810 as an institution of the new University of Berlin. Originally based on the zoological parts of the Royal Art Collection of the Prussian King as well as a few smaller collections, the museum quickly grew by acquiring numerous and mostly private collections. By the beginning of the 20th century, it owned reference specimens for more than 200,000 of the roughly 400,000 known animal species (Kuhlgatz 1907, 246). The rapid expansion of the museum was accompanied with an

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effort to serve research and academic education as well as public education. As Hinrich Lichtenstein, the first director of the museum, put it in 1816: “These institutions [museums] are funded by the state with the threefold goal to support science itself, the study of science, and the general education of the public.” (Lichtenstein 1816, p. 106)

In the early days of the museum, taxonomy and the identification of new species dominated the collection-based research. Lichtenstein’s efforts were directed towards a comprehensive collection of as many species as possible and he even started to sell “duplicates” in order to be able to buy reference objects of new species (e.g. Lichtenstein, 1823). In 1857, Wilhelm Peters succeeded Lichtenstein as the director of Zoological Museum. Peters had been an assistant of Johannes Peter Müller and introduced anatomical and physiological research as a further focus of the museum (Brauer 1910, 381). Karl August Möbius succeeded Peters in 1887 and again changed the research focus of the museum. Evolutionary biology made new topics such as the geographical distribution of animals important scientific questions and Möbius utilized the collections of the museum to propose a system of 12 geographical regions that he presented as an alternative to Alfred Russel Wallace’s influential account (Möbius, 1891).

In addition to the spread of collection-based research, universities in 19th century Germany also made increasing use of teaching collections. Furthermore, many collections served both research and teaching purposes. The Zoological Museum had specific opening hours for university students as Lichtenstein’s description of the access rules from 1816 illustrates: “Students have unrestricted access to the museum at specific hours (now Wednesday from 4

Penultimate draft – final version forthcoming in *Studies in History and Philosophy of Science Part A* to 6 and during winter 2 to 4 of the same day). They do not get a specific ticket but simply write their name in a book. Students of other universities are also welcome; furthermore all scholars have access as they presence can help the education of the students” (Lichtenstein, 1816, p. 107). While academic teaching was a core function of the Zoological Museum in its early days, the situation changed under Peters, who reportedly considered teaching “nothing but a burden” (Brauer, 1910, p. 384). Eventually, a separate teaching collection was created at the zoological department and the Zoological Museum focussed on research and the public presentation of science.

The creation of a separate teaching collection in Berlin is by no means an isolated case. On the contrary, in the course of the 19th century zoological (and other biological) teaching collections mushroomed all over Germany. The rise of biological teaching collections strikingly matches the rise of morphology in German biology. First-generation morphologists such as Friedrich Tiedemann (1781-1861) and Johann Friedrich Meckel (1781-1833) were also pioneers in the creation of anatomical and zoological collections. The simultaneous rise of morphology and biological teaching university collections was no coincidence. The prominence of the “study of form” in German biology of the 19th century made material objects and university collections indispensable teaching aids. Of course, many biological university collections were not only teaching collections but also served research interests. However, there is a lot of evidence for the extraordinary importance of collections in biological education of the 19th century. A clear indicator is the emergence of a professionalized market for biological models and other scientific teaching aids. Although scientific models are not an invention of the 19th century, their popularity dramatically

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increased especially in the second half of the 19th century. In the case of biological models, there are well-documented cases such as the glass models of Leopold and Rudolf Blaschka (Niepelt and Wiegmann, 2001) as well as the wax models of Adolf and Friedrich Ziegler (Hopwood, 2002). However, there were many other biological model makers that have received less attention by historians of science such as Robert Brendel, Paul Loth, Paul Osterloh, Marcus Sommer, and Rudolf Weisker.³ Similar developments occurred in other disciplines. For example, the mathematical models of Alexander von Brill (1842-1935) were used as teaching tools all over Germany and the *Dr. F. Krantz Rheinisches Mineralien-Kontor* sold crystal models for teaching aides. These models were often produced in large quantities due to a large demand from teaching collections.

Research and teaching were the core functions of German university collections in the 19th century. In some institutions such as the Zoological Museum, the public presentation of science joined research and teaching as a third mission. However, the Zoological Museum was an exception and the majority of university collections paid little attention to the public presentation of science. This does not mean that science communication was not an issue in 19th century Germany. On the contrary, science became a topic of increasing public interest as recent literature on science popularisation in Germany has shown in detail (e.g. Daum 2002). University collections usually remained at the periphery of this development even if there is some evidence for the involvement of university collections in science

³ For a list of mostly German model makers see <http://www.universitaetssammlungen.de/modelle/hersteller>

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communication such as their presence in travel guides of the 19th century (Nicolai, 1833) or
the use of scientific models at World Fairs.⁴



Figure I: Gold medal winning model of a skull from the Anatomical Institute in Berlin at the World Fair in St. Louis (1904).

The Marginalization of University Collections

In her dissertation *Between Two Worlds*, Marta Lourenço describes the time between 1800 and 1930 as a “golden age” of university museums and collections. Lourenço’s assessment largely fits the situation in Germany; but there are certainly some differences between Germany and other European countries such as the rather small number of university museums in Germany that reached out to the public. However there can be no doubt about

⁴ The acquisition book of the zoological collection has handwritten comments that a Blaschka model was lost, because it was shipped to a World Fair and not returned. For other examples, see Hopwood (2002, 1) and Daston (2004, 246) and Figure I.

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the dramatic increase of the number as well as the importance of university collections both in research and education.

Moving on to the 20th century, the situation of German university collections becomes far more complicated and volatile. One can certainly extend the “golden age” of university collections in Germany from the 19th century until 1914. Examples of new institutions in the beginning of the 20th century include the Museum for Marine Science in Berlin (1900), the Chemical Museum in Berlin (1903), the Phyletic Museum in Jena (1907), the Geological Museum in Bonn (1911), and the new observatories in Dresden and Frankfurt (both 1914). Historical research on the situation of university collections in Germany between 1914 and 1945 is still largely missing and many more detailed case studies would be necessary in order to make reliable generalizations. Our data is also only of limited help. Although the database indicates a rather healthy growth of university collections during the Weimar Republic, much historical work would be needed for a helpful contextualization of the data. Unsurprisingly, there are almost no foundations of new collections during the world wars. During the Second World War, we know of only one new university collection that was created in 1941 - a collection of “racial heads” in Tübingen.

In this section, we want to focus on the history of university collections in the second half of the 20th century. The situation of university collections in Post-War Germany provides a striking contrast to “the golden age of university collections” and suggests an often dramatic change in the attitude of the sciences towards university collections. The aim of this section is to offer a more specific picture of this process.

A cursory look at the data presented in the first section does not seem to back the idea of a marginalization of university collections in the second half of the 20th century. On the contrary, Table I shows a growth of the number of university collections during the 20th century. As mentioned earlier, the data may be skewed in favour of 20th century collections because they are better documented but there is no reason to believe that the number of university collections actually declined at any time except 1943-1945 where we know about more than 50 disbanded or destroyed collections. Table II shows that the growth of the number of university collections slows down considerably in some disciplines such as crystallography and geodesy. However, in other areas such as ethnology the growth of collections quickly accelerates in the 20th century (see Table III).

Despite heterogeneous developments in different disciplines, we still think that a closer look at the data reveals a marginalization of university collections in Germany especially in the second half of the 20th century. Recall that one aspect of the stunning growth of university collections in 19th century was the simultaneous growth of universities and of the number of students. In 1830, there were roughly 16,000 students compared to almost 33,000 students in 1900. However, this growth is dwarfed when compared to the developments of the 20th century. In 1910, there were already 55,000 students enrolled in German universities and in 1930 the number had increased to 100.000. In Post-War Germany data is available from 1960 for both East and West Germany: 277,300 students in 1960 (BRD: 247,200, DDR: 30,100), 456,000 students in 1970 (BRD: 412,000, DDR: 44,000), 823,000 students in 1980 (BRD: 791,000, GDR 32,00), 1,504,100 students in 1990, and 1,798.800 students in 2000.⁵

⁵ Data for 1910 and 1930 is from Ringer (2010, 202). For 1960 to 1990 see Neave (2010, 42). The data for 2000 are from Federal Statistical Office of Germany, see their website www.destatis.de.

Table IV shows the number of students in relation to university collections with known founding dates:

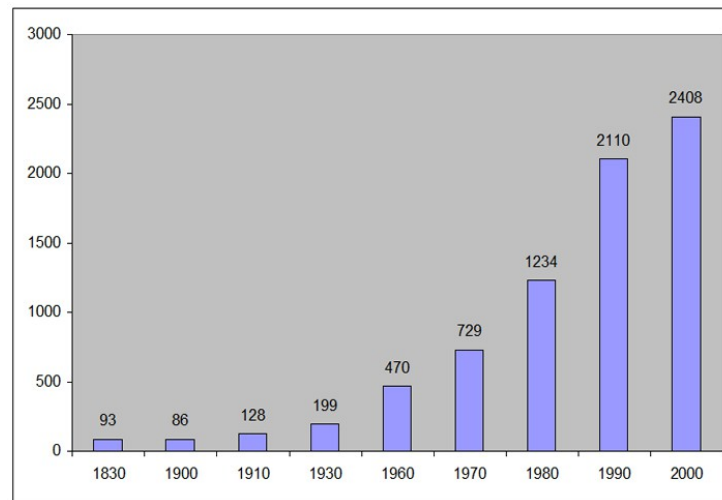


Table IV: Development of the student-collection ratio (y) between 1830 and 2000 (x).

Table IV cannot provide an entirely reliable picture of the student-collection ratio as our database cannot claim to provide a complete account of university collections. Furthermore, Table IV is based only on the 769 (out of 1094) collections with known founding dates. However, the diagram still illustrates a dramatic development of the student-collection ratio. In the beginning of the 20th century, there are roughly 86 students for every database entry with a known founding date. By the end of the 20th century, there are roughly 2408 students for every database entry with a known founding date.

This development provides clear empirical evidence for the institutional marginalization of university collections in Germany.⁶ There can be no doubt that the rapid growth of student numbers without corresponding growth of university collections fundamentally altered the visibility and institutional role of university collections. Furthermore, the increase in student numbers came with a general expansion of universities and research in Germany. Therefore, similar diagrams could be made by comparing the number of university collections to the number of universities or scientists in Germany. While the data provides clear evidence for the marginalization of scientific collections at German universities, it offers little help in answering the question *why* this marginalization occurred. In the remainder of this section we want to at least outline a possible answer by focussing on the changing function of university collections.

Recall that we explained the growth of university collections during the 19th century partly by pointing out that they were widely recognized as indispensable both in research and education. One possible explanation for the marginalization of university collections in the 20th century would be the assumption that university collections simply lost these functions without gaining importance in other ways. We think that this explanation is ultimately too simple but it is not hard to see why it is attractive. Consider the case of zoology and our example of the variety of collection-based research at the Zoological Museum in Berlin. Turning to the 20th century, one obvious development is the declining importance of

⁶ This is especially evident in the case of West Germany between 1960 and 1989 and the reunified Germany since 1989. East Germany did not establish “mass universities” in the same sense as many countries in Western Europe, and universities seem to have kept more a visible role in East Germany in general. This needs clarification.

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morphology that has often been presented as a “revolt from morphology” (Allen, 1975, p. 41). According to Allen, this revolt was based on a fundamental shift from descriptive morphological analysis to experimental research practice. Furthermore, it seems that this shift also changed the role of material objects in research. While morphology often relied on objects in museums and university collections, new generations of biologists increasingly focussed on laboratory-based research. The “revolt from morphology” has led to much discussion in the history of biology and requires at least two qualifications. First, many historians of biology have criticized the rhetoric of “revolt” as ignoring important continuities and misleadingly presenting the developments as a Kuhnian scientific revolution instead of a gradual development (Maienschein, 1991, p. 172). Second, the discussion among historians has been mostly concerned with developments in the United States and has not considered the development in the European contexts. Lynne Nyhart has shown that both the intellectual and institutional situation in Germany at the end of the 19th century was very different from the situation in America (Nyhart, 1995, part 3).

In comparing the situation of the 19th century with the *second half* of the 20th century, however, the contrast between collection-based and laboratory-based research becomes obvious and uncontroversial. Furthermore, one may assume that this contrast already proves that university collections lost their importance in research. However, a closer look shows that the situation was more complicated. Consider, for example, the situation of botanical collections in the second half of the 20th century. Again, one may assume that the decline of traditional plant morphology led to a breakdown of the research functions of botanical collections and left them without any clear role in scientific practice. However, this is not

true. Evidence for the remaining importance of botanical collections comes from our database that lists 46 botanical collections that were created between 1950 and 2000, the majority of them herbaria. Herbaria offer a helpful example of the continued use of university collections in research. First and foremost, herbaria are still of indispensable importance as archives in taxonomic research and provide taxonomical types, i.e. particular specimens of organisms to which the scientific names are formally attached. Without the conservation of specimens through herbaria, it would often be impossible for botanists to determine whether they have actually discovered a new species. In this sense, herbaria serve as archives that allow the identification of new species but also the conservation of already known and sometimes endangered or even extinct species. Furthermore, herbaria serve research functions not only despite but also *because* of new experimental methods and laboratory-research in botany. Molecular biology, genetics and biochemistry allow the use of herbaria as valuable data sources for a variety of new ecological, evolutionary, and microbiological research questions and further broaden the scope of collection-based botanical research compared to the 19th century (see also Funk, 2004).

The ongoing importance of herbaria for collection-based research is not an isolated case. Analogous points could be made for other biological collections such as palaeontological and zoological collections as well as many medical and geological collections. Furthermore, there are other types of collections that are used in research even if their research functions are very different from botanical collections. Examples include archaeological, ethnological and many other collections in the humanities that became increasingly popular in the 20th century. Finally, it is important to point out that not only collection-based research but also

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collection-based teaching continues in the second half of the 20th century. Often, even models and other objects from the 19th century are still used in lectures and classes.⁷ Furthermore, our database also lists new biological university collections that were created in the second half of the 20th century specifically for teaching purposes such as the collections for biology education in Berlin and Jena.

A look at the functions of university collections in the second half of the 20th century leads to a complex picture. University collections did indeed lose functions in research and education but they also kept and even gained new functions. This raises the question of how university collections became marginalized despite the continuity of collection-based research and education. We think that there is a rather simple answer to this question that we will continue to illustrate with the example of biological collections. The decline of morphology and the rise of laboratory-based biology did not make collection-based research and education obsolete and even created new uses of these collections such as research that relies on DNA analysis. However, the dominance of new research methods and questions pushed collections from the centre to the periphery of attention in the biological sciences. Collection-based research still exists and there may be more collection-based research projects today than 100 years ago. However, these research projects are vastly outnumbered by laboratory research that is not based on the holdings of university collections. The same is true in the case of collection-based teaching. Biological models and other scientific objects are still used in lectures but the curricula of students have changed dramatically and require

⁷ During our work on the database, we collected a lot of oral evidence for the continued use of biological teaching collections from the 19th century.

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an increasing amount of theoretical as well as practical knowledge that is not associated with university collections. University collections did not (at least not primarily) become marginalized because they lost their functions but because of the increasing prominence of other types of research that attracted the attention of scientists.

A Rediscovery of University Collections as Material Heritage?

In the last section, we argued that university collections in Germany became increasingly marginalized in the second half of the 20th century because collection-based research and education was often pushed from the centre to the periphery of scientific disciplines. The data represented in Table IV does not indicate a reversal but rather a further acceleration of this trend towards the end of the 20th century. Given this development, the prospects of a reconsideration or even of a rediscovery of university collections as crucial elements in scientific practice may look dim.

However, we still think that the situation since the 1980s indicates an important change in the attitude towards university collections. So far, we have only talked about the *institutional* marginalization of university collections as it is exemplified in the changing student-collection ratio. However, this institutional process also came with a *theoretical* marginalization of university collections during the 20th century. Scientists did not publicly denounce the importance of university collections and they rarely justified the institutional processes that pushed university collections to the periphery of their disciplines. Instead, they simply stopped paying attention and moved on to topics they considered more fruitful

Penultimate draft – final version forthcoming in *Studies in History and Philosophy of Science Part A* and timely. The decreased visibility of collection-based research and education also enforced their theoretical devaluation. At best, collections were still perceived as valuable but somewhat marginal and old-fashioned parts of a discipline. At worst, they were perceived as valueless, and obstacles to more important research topics. There are countless examples of university collections that were moved to basements or even disbanded because the space was needed for laboratories and the “*really* important” research projects of departments.

In the following, we want to argue that there has been a theoretical reconsideration of university collections since the 1980s that can be described as a “rediscovery of university collections as material heritage”. In order to understand this development, it is first important to note that the marginalization of university collections did not imply a general marginalization of the material dimensions of scientific practice. Laboratory research, for example, is not less material than collection-based research. However, the material objects that constitute laboratory equipment and contemporary experimental systems often have a short life span that prevents them from becoming part of scientific collections.

Therefore, it is not surprising that emerging debates about material cultures and material objects in the science and technology studies of the 1980s rarely referred to scientific collections but instead focussed on laboratory research and the role of experiments in scientific practice. In the centre of these studies are usually elusive scientific “laboratory-objects” such as the peptide TRF(H) in Latour and Woolgar’s *Laboratory Life* (1979), plant proteins in Knorr-Cetina’s *The Manufacture of Knowledge* (1981), or neurons and axons in Kohler’s *Art and Artifact in Laboratory Science* (1985). And even if we move beyond the

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researched objects and consider entire experimental systems and laboratory settings, we usually won't find objects that are likely to end up in university collections. Knorr-Cetina, for example, describes a laboratory as a "local accumulation of instruments and devices within a working space composed of chairs and tables. Drawers full of minor utensils, shelves loaded with chemicals and glassware. Refrigerators and freezers stuffed with carefully labelled samples and source-materials: buffer solutions and finely ground alfalfa leaves, single cell proteins, blood samples from the assay rats and lysozymes" (Knorr-Cetina 1981, 4).

On the one hand, the early wave of laboratory studies can be seen as further evidence for the theoretical marginalization of university collections. These studies describe what the scientists themselves as well as the protagonists in the science and technology studies considered the core of scientific practice: laboratory work and not collection-based research. On the other hand, the emerging interest in the material dimension of science contributed to the theoretical reconsideration of university collections as material heritage. Even if the literature in the science and technology studies initially paid little attention to university collections, it emphatically pointed out that science has not only a theoretical but also a material heritage. Scientific objects are not negligible but crucial elements in the understanding of scientific practice. This reconsideration of the materiality of scientific practice also allowed university collections to emphasize their role as preservers of the material heritage of the sciences.

Among the first signs of a reconsideration of university collections as material heritage is the international debate about the "crisis" of university museums during the 1980s (see

Penultimate draft – final version forthcoming in *Studies in History and Philosophy of Science Part A* Lourenço 2005, chapter 5-6). According to Alan Warhurst (1986), university museums were caught in a triple crisis that concerned their identity, recognition, and resources. The diagnosis of a crisis at university museums strongly resonated in the museum studies of the 1980s and 1990s and resulted in a quickly growing literature towards the end of the 20th century. Although this debate was concerned with the problems university museums (and to a smaller degree university collections) face, we still think that this debate indicates an important reconsideration. In the crisis debate, the role of university museums and collections became a topic of active discussion again, when the theoretic marginalization of university collections had created a situation in which this was usually not even considered. Furthermore, the emerging literature on material cultures and the role of material objects in scientific practice provided a promising starting point for challenging the identity crisis: sciences do not only have a theoretical but also a material heritage and university collections are of outstanding importance because they preserve this heritage.

This line of thought did not only challenge what we have described as “theoretical marginalization” of university collections, it has also created new functions for collections. One example is the increased recognition of university collections as research resources for the history of science. As university collections preserve the material heritage of the sciences, they provide important primary sources for the history of science that complement libraries and traditional archives. Prominent examples of historical research that is at least partly based on university collections in Germany include Hopwood’s (2002, 2004) accounts of the history of embryology in the 19th century, a variety of publications on the Blaschka

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glass models (Niepelt and Wiegmann 2001), Schnalke's (1995) research on the history of
moulages, and Meinel's (2004) account of molecule models.

Conclusion: From a theoretical to an institutional rediscovery?

In the last section, we described a process that challenged the marginalization of university collections. Science has not only a theoretical but also a material heritage and the increasing recognition of the role of university collections in the preservation of this heritage has changed the attitudes towards them. The vastly growing number of publications and research projects on university collections and their holdings reflect this development and indicate that university collections have largely overcome their crisis of identity and recognition.

Even if there can be little doubt about the theoretical reconsideration of university collections in the past decades, it remains a complicated and largely open question as to what degree this development affects their institutional situation. Our database documents only 29 newly founded scientific collections since 2000. The simultaneous growth of student numbers from 1,798,863 to 2.217.294 indicates that there is no reversal of the institutional trends described in the last sections.⁸ At the same time, there are developments that point towards an improving institutional situation of university collections. On an international level, the most prominent and important examples are the creation of the European Network *Universeum* in 2000 and of ICOM's *International Committee for University Museums And Collections* (UMAC) in 2001.

⁸ The data is from Federal Statistical Office of Germany, see www.destatis.de.

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In Germany, the development has been slower but has recently gained considerable traction. Since 2010, there are annual collection conferences (“Sammlungstagung”) and several universities have created positions for “collections coordinators” that support collections across the departments. In 2011, the *German Council of Science and Humanities* published recommendations on “Scientific Collections as Research Infrastructures.” The council argued that “collections play an important role as infrastructure for research and teaching” (Wissenschaftsrat, 2011, p. 6) and proposed measures to strengthen their institutional role at German universities. One result is a national coordination body for university collections that has been established at Humboldt University Berlin in 2012. Furthermore, the Federal Ministry of Education and Research as well as the Mercator Foundation have newly created funding schemes specifically for collection-based research and education.

There are indeed signs that the theoretical reconsideration of university collections over the past few decades is leading towards an improved institutional situation of university collections in Germany. However, it is important to understand this process in the context of their changing functions. A rediscovery of university collections will not lead back to the “golden age” of the 19th century when university collections were at the centre of research and education across scientific disciplines. Instead, a rediscovery of university collections will require a new identity of university collections that will also be based on their role in preservation of the material heritage of the sciences.

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